

LABORATORY

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# WATERTOWN ARSENAL LABORATORY

## MEMORANDUM REPORT

NO. WAL-322/4

COMPARATIVE MACRO-STRUCTURE OF ARMOR PLATE INGOTS.

BY

S. L. CONNER

1ST LT., ORD. DEPT.

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COMPARATIVE MACRO-STRUCTURE OF ARMOR PLATE INGOTS

In ingot 444 the spots appearing under etching that are located away from the center, are believed to be formed from gas evolved by a mold wash that contained more shellac than is normally used. Disregarding these spots, the following remarks apply to all the ingots.

In the first place, whether the cavities exposed on etching are porosity or segregation has not been determined. Since all the steel was well killed when poured and showed excellent shrinkage in the sink head, it is not believed that gas evolved on cooling is in any way responsible. In any ingot, segregation toward the center, and primary and secondary piping are inevitable. The mold used is probably the poorest shape, except for a circle, for the production of sound ingots. The ingots as produced are sound material as good as could be normally expected. The practice in making the steel shows slight variations. These are shown in the following table:

Ingot No.	Mn. %	Time added before tapping: min.	Si. %	Time added before tapping: min.	Temp. when poured	Size of runner: square	Total time to melt: min.	Power: KW	Time used: Hr	Temp: °C	Time and date of pouring
435	0.07	5	0.08	4	hot	1"	94	210	200		10.59 AM, 3/21/32
436	0.07	5	0.08	4	hot	1"	62	200	400		12.04 PM 3/21/32
437	0.07	5	0.08	3	hot	1"	63	190	400		2.08 PM 3/21/32
444	0.22	6	0.08	2	hot	1"	86	240	200		9.58 AM 4/20/32
445	0.22	10	0.08	4	cool	3/4"	71	200	400		11.40 AM 9/20/32

\* final additions.

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The following is the charge used on all heats: (deoxidizers are included)

Bar Stock (C .40; Mn .65; Si .125; S .037; P .016)	1408 lbs.
Armco Iron (C .05)	83 "
Ferro-Molybdenum (C .04; Si 6.48; Mo 63.98)	5.7 "
Ferro-Vanadium (C .53; Si 1.18; Va 37.68)	3.45 "
Ferro-Chromium (C .18; Cr 68.82)	8.75 "
Ferro-Manganese (Mn 97.3)	435) 444)
	436) 0.35 lb. 445)
	437)
Ferro-Silicon (Si 93.0)	0.4 "

They were the 6th, 7th, 8th, 9th, 10th, heats on a cindered magnesia crucible. Lining condition excellent for all heats. All were poured from under a small amount of viscous high magnesia slag.

The top discs cut from ingots 435, 436, 437, were located 1.5" below the hot top. The top discs from 444 and 445 were located 2.25" below the hot top. The bottom discs from 435, 436, and 437 were located 0.5" above the bottom taper. The bottom discs from 444 and 445 were located even with the bottom taper.

Temperature change in the induction furnace is extremely rapid. The practice is to superheat slightly, shut off the power, and pour when ready, waiting time is seldom as long as one minute. The pouring temperature is, therefore, a matter of estimate. An examination of the above data leads to three general conclusions: which will be tested in future ingots:-

- (1) The final silicon addition should be made as late as possible.
- (2) The smaller runner is preferable.
- (3) The high mold temperature is desirable.

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